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Internet use and problematic Internet use among adolescents in Japan: A nationwide representative survey

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ABSTRACT

Introduction: Japan is assumed to have serious health and social problems due to Internet overuse, but little is known about the actual conditions. This study was conducted to investigate the prevalence of problematic Internet use (PIU) and associated Internet use in adolescents in Japan.
Methods: A nationwide survey of adolescent Internet use was conducted in 2012 and 2013. The participants were 100,050 students from randomly selected junior and senior high schools nationwide who gave valid responses to a self-reported questionnaire. The questionnaire included questions on Internet use and the Japanese version of the Young's Diagnostic Questionnaire (YDQ) as well as other questions related to lifestyle habits. Internet users were classified by gender according to three categories on the basis of their YDQ scores: adaptive use, maladaptive use, and PIU.
Results: The estimated prevalence of PIU was 6.2% in males, 9.8% in females, and 7.9% in total; it closely correlated with female gender, school grades, and number of Internet hours. The following common and gender-specific applications that conferred a risk of PIU were identified: downloading (both genders), online gaming (males), social networking services, blogs, and bulletin boards (females).
Conclusions: A cross-sectional survey using YDQ of a large number of high school students yielded a PIU prevalence of 7.9% in Japan. This study showed that problems associated with Internet overuse have already become serious; therefore, planning and implementation of prevention and control measures is urgently required.

1. Introduction

Increasing prevalence of the Internet has resulted in concerns about excessive Internet usage and its consequences on health and social functioning. A variety of terms have been used to describe this condition, including Internet addiction, compulsive computer use, Internet dependency, pathological Internet use, problematic Internet use, and virtual addiction (Kuss, Griffiths, Karila, & Billieux, 2014). Henceforth, the term "problematic Internet use" (PIU) will be used to describe this condition, as this term has been widely used in many studies (Shapira et al., 2003; Aboujaoude, 2010; Spada, 2014). The diagnostic criteria or guidelines for PIU have been proposed by several investigators (Shapira et al., 2003; Ko et al., 2005a; Tao et al., 2010), but none of these have achieved a global consensus. Recently, the American Psychiatric Association published the updated version of the DSM and included Internet Gaming Disorder in Section III as a condition requiring further research (American Psychiatric Association, 2013), which is expected to help establish a globally approved definition and diagnostic guidelines for PIU.

Epidemiological studies on PIU prevalence have shown wide variations. According to a recent review, the prevalence has ranged from 0.8% in Italy to 26.7% in Hong Kong (Kuss, Griffiths, Karila, & Billieux, 2014). The diverse prevalence rates arose from differences in assessment tools and cutoffs used in surveys and the nature of participants surveyed (Kuss et al., 2014). Although many epidemiological studies have been published on the prevalence of PIU, the number of surveys

Abbreviations: AIU, Adaptive Internet use; MIU, Maladaptive Internet use; PIU, Problematic Internet use; YDQ, Young's Diagnostic Questionnaire.

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whose participants were representative of the general population is limited. Only two studies have been conducted worldwide, one in Norway and one in the USA, and the rates were 1.0% and 0.7%, respectively (Bakken, Wenzel, Götestam, Johansson, & Øren, 2009; Aboujaoude, Koran, Gamel, Large, & Serpe, 2006). Studies using samples representative of young Chinese, Norwegians, and Finns showed prevalence rates of 8.8% in Chinese, 2.0% in Norwegians, and 1.7% and 1.4% in Finnish boys and girls, respectively (Johansson & Götestam, 2004; Kaltiala-Heino, Lintonen, & Rimpelä, 2004; Xu et al., 2012). Studies using samples representative of local or national student populations have been scarce. Durkee et al. (2012) conducted a survey in adolescent participants who were randomly selected from schools in 11 European countries. The overall PIU rate was 4.4%, and PIU was higher in males than in females (5.2% vs. 3.8%) and differed among countries (Durkee et al., 2012). In Taiwan, 15.3% of college students in a nationally representative sample were addicted to the Internet (Lin, Ko, &Wu, 2011). A smaller study of student representatives of schools in a Greek city indicated a rate of 5.9% (Siomos, Dafouli, Braimiotis, Mouzas, & Angelopoulos, 2008). Although the number of these studies is limited, the estimated prevalence of PIU appears higher in Asian samples than in other regions (Johansson & Götestam, 2004; Kaltiala-Heino, Lintonen, & Rimpelä, 2004; Siomos, Dafouli, Braimiotis, Mouzas, & Angelopoulos, 2008; Lin, Ko, &Wu, 2011; Durkee et al., 2012; Xu et al., 2012).

Prevalence rates ascertained by other types of studies, particularly in adolescents, have been researched more extensively. Results show that in European samples, prevalence rates range from 1.2% to 5.0% (Morrison & Gore, 2010; Barke, Nyenhuis, & Kröner-Herwig, 2012; Poli & Agrimi, 2012; Lopez-Fernandez, Freixa-Blanxart, & Honrubia-Serrano, 2013; Kuss et al., 2013a, b). Similar prevalence rates have been reported in samples from North America (Liu, Desai, Krishnan-Sarin, Cavallo, & Potenza, 2011; Yates et al., 2012). In Japan, a small study as part of a wider international collaborative study reported the prevalence of PIU among adolescents in western Japan as 3.1% and 6.2%, as measured by the Internet Addiction Test (Young, 1998a) and the Revised Chen Internet Addiction Scale (Mak et al., 2014a, b), respectively.

Similar to studies using random or representative samples, other types of studies have shown a tendency toward higher prevalence rates in Asian samples (between 1.2% and 26.7%) than in samples of other regions (Yen et al., 2008; Cao, Sun, Wan, Hao, & Tao, 2011; Wang et al., 2011; Shek & Yu, 2012; Wang et al., 2013; Mak et al., 2014a, b).

In this study, we investigated the prevalence of PIU and Internet use associated with PIU in Japanese adolescents. PIU is thought to be a serious problem in Japan, but available data has been limited. In the present study, we estimated the prevalence of PIU and also sought to identify factors that are associated with PIU in areas related to Internet use, including time spent on the Internet, Internet services, and electronic devices used to access the Internet. This study, in which a large number of participants were included and a random sampling method was employed, is expected to provide reliable data on the characteristics of Internet use and PIU in adolescents in Japan.

2. Methods

2.1. Study participants

This study was part of a series of large-scale cross-sectional surveys that were conducted every 4 years since 1996 and every 2 years since 2010 (Munezawa et al., 2011; Morioka et al., 2013). This study used a stratified, single-stage cluster sampling. As of May 2011, 10,018 junior high schools and 4603 senior high schools (14,621 in total) were registered. Of these, 140 junior high schools (selection rate, 1.4%) and 124 senior high schools (selection rate, 2.7%) were selected. As part of the selection process, we divided Japan into regional blocks and randomly selected schools from each block. To avoid any sampling bias toward any regional blocks, stratified sampling was performed using regional blocks as the strata. All students enrolled in the sampled schools were the participants of this study.

In the Japanese educational system, children enter the elementary school at the age of 6 years and complete this stage of their education by the age of 12 years. They then enter junior high school for 3 years followed by a further 3 years at senior high school. Primary and junior high school education is compulsory. According to the Japanese government, although senior high school is voluntary, nearly 98% of junior high school students continue senior high school education (Ministry of Education, Culture, Sports, Science and Technology, 2012). The years at junior high school are termed as the 7th–9th grade, and those at senior high school are termed as the 10th–12th grade.

2.2. Survey procedure

The principal of each selected school was sent a letter requesting their cooperation in the study, along with questionnaires and envelopes equal to the number of students enrolled at the school. At participating schools, each teacher was asked to deliver the questionnaires to the students. After filling out the questionnaire, each student was requested to place the completed questionnaire in the envelope supplied and then seal the envelopes with an adhesive flap. The participating teachers collected the sealed envelopes and returned these to the Nihon University School of Medicine. The survey was conducted between October 2012 and March 2013. The study was approved by the Ethics Committee of the Nihon University School of Medicine.

2.3. Response rate

Of the selected junior and senior high schools, 94 and 85 returned responses, respectively (school cooperation rate: 67.1% and 68.5%, respectively). Thus, 179 out of 264 junior and senior high schools returned responses (overall school cooperation rate: 67.8%). Of the 109,847 student participants, 101,134 responded to the questionnaire (38,871 [92.6%] junior high and 62,263 [91.7%] senior high school students, aged 12–19 years, mean age 15.5 years, the ratio of male to female was 0.94), giving a 92.1% overall response rate. The eventual response rates were 59.8% and 61.3% for junior and senior high schools, respectively (60.7% in total).

From the collected questionnaires, 1084 were excluded because the respondent's sex or grade was not specified or the answers were inconsistent e.g. In one question participants stating they were senior high school students, but in another that their ages were 14 years old or younger. Data from the remaining 100,050 questionnaires (38,494 and 61,556 from junior and senior high schools, respectively) were analyzed.

2.4. Measures

The questionnaire used for this study comprised 77 self-reported questions. The content of previous surveys comprised the lifestyle habits of Japanese adolescents (e.g., drinking alcohol, smoking, eating, and sleeping). In the present study, questions on Internet usage were introduced. Table 1 shows actual questions that were included in the questionnaire. Respondents were asked about average daily Internet use for non-study purposes on weekdays and weekends. An additional two questions related to the types of Internet services and electronic devices used to access the Internet during the 30 days prior to the survey. To assess problematic Internet use, we used the Japanese version of the Diagnostic Questionnaire developed by Young (YDQ) (Young, 1998b). The criteria are evaluated using eight questions, with “yes” or “no” as the answers, and scores ranging from 0 to 8. Although the original study proposed a

Table 1
Questions and response items on Internet use included in the questionnaire.

Questions	Response items
1. How long did you spend on the Internet (Internet services include using a personal computer, cellphone, smartphone etc. and include gaming and email) on average on a school day within the previous 30 days?	1) 0, 2) <1 h, 3) 1 = ≪2 h, 4) 2 = ≪3 h, 5) 3 = ≪5 h, 6) 5 h = <
2. The same question as above on a non-school day	As above
3. What kind of Internet services have you used in the past 30 days? Choose all services that apply	1) Internet search for information and news (Google, Yahoo etc.) 2) Email 3) Chat, Skype or Messenger 4) Blog, BBS (2ch etc.) 5) SNS (social networking services) (Facebook, Twitter, Mixi etc.) 6) Online gaming 7) Downloading or streaming services (YouTube, Niconico etc.) 8) Others
4. What kind of electronic devices have you used to access the Internet in the past 30 days? Choose all devices that apply	1) Personal computer (PC) 2) tablet PC 3) portable gaming machine 4) smartphone 5) cellphone 6) others
5. Young's Diagnostic Questionnaire	Japanese version - 8 items

dichotomized distinction, i.e., dependent Internet users vs. non-dependent Internet users, with a cutoff of 5 (Young, 1998b), subsequent studies using the YDQ have utilized three subscales of severity. These same measures were used in the present study (Bakken, Wenzel, Götestam, Johansson, & Øren, 2009; Johansson & Götestam, 2004; Durkee et al., 2012). The terminology of the three subcategories followed that proposed by the previous study, with slight modifications: "Adaptive Internet Use" (AIU: scoring 0–2), "Maladaptive Internet Use" (MIU: scoring 3–4), and "PIU" (scoring ≥5).

2.5. Statistical analyses

The participants were stratified into four category groups (no Internet use, AIU, MIU, and PIU), and the distribution of participants among these groups, segmented by school grade and gender, was calculated. The "no Internet use" group included those who had not used the Internet for ≥30 days prior to the survey. We examined the relationships between the three category groups of Internet use and the average daily hours of Internet use as well as the relationship between types of Internet services and electronic devices used to access the Internet. The statistical testing on gender differences and trends according to the school grade or the number of hours spent on the Internet was performed using binomial logistic regression analyses and was age adjusted.

To further examine the relationships between PIU and Internet services, binomial logistic regression analyses were performed. The dependent variable was the dichotomous classification of Internet users (AIU and MIU = 0 and PIU = 1), whereas the school grade and use of each Internet service for the preceding 30 days (not used = 0 and used = 1) were entered in the models as independent variables. Models for males and females were separately constructed to better delineate the possible gender-linked features of the relationships. Odds ratios were calculated on the basis of each multiple logistic regression analysis, with 95% confidence intervals. When a multiple logistic regression model was constructed, we used the forward selection method on the basis of likelihood ratios. To estimate the contribution of each Internet service in the development of PIU, the population attributable risk was calculated for each model constructed.

The level of significance for statistical testing was set at $P < 0.01$. The Statistical Package for the Social Sciences (SPSS) version 17.0 for Windows (SPSS, Inc., Chicago, USA) was used for all analyses.

3. Results

3.1. Prevalence of PIU and MIU

The consistency of the Japanese version of YDQ was tested with Cronbach's alpha. It was 0.745 with standardized item alpha of 0.750, showing the acceptable level of internal consistency. The prevalence of PIU was 6.2%, 9.8%, and 7.9% in male, female, and all participants, respectively (Table 2). The prevalence of MIU was higher than that of PIU in males, females, and total participants, with values of 13.7%, 18.3%, and 15.9%, respectively. There was a clear and significant trend showing that the prevalence of both PIU and MIU increased with the advancement of school years. For example, the rate of PIU among all 7th grade students was 3.9% but increased to 9.2% among 12th grade students. The prevalences of PIU and MIU were higher for females than for males for all grades and overall. The results of logistic regression analyses showed that all of these differences were statistically significant at $P < 0.01$. The difference was particularly pronounced among younger students (7th and 8th grades) in which the prevalence in females was more than double that in males.

3.2. Hours on Internet and PIU

Participants were asked about the average number of daily hours spent on the Internet in the preceding 30 days, other than for study purposes, both on weekdays and weekends (Table 3). Those who did not use the Internet in the preceding 30 days or did not report hours on the Internet were excluded from the table. We found statistically significant differences in the number of hours spent on the Internet among the three YDQ categories for both genders, on weekdays and weekends (Table 3). The percentages clearly tended to rise with the increase in Internet hours for both male and female students with PIU. On weekdays, 33% males with PIU and 30% females with PIU spent ≥5 h on the Internet, whereas the corresponding figures for AIU were nearly 10% for both genders. On weekends the trend was even more pronounced. Although not so clearly observed as the increase in the percentages for PIU, the percentages for MIU tended to increase with a rise in Internet time for both genders and in total.

3.3. Internet applications and electronic devices and PIU

Table 4 compares the type of Internet applications and electronic devices used to access the Internet within the preceding 30 days among the three YDQ categories. As these two questions were in multiple choice formats, the percentages in the table do not add up to 100. Regarding the type of Internet applications, the percentages of applications endorsed were the highest among PIU for all the applications, followed by those for MIU and AIU. High percentages were observed for downloading applications, information searches, and emails for both males and females, irrespective of the YDQ categories. However, there was a distinct gender-linked difference in preferences for Internet applications. Online gaming was much more preferred by males than by females. The percentages for this application in males were more than double the percentages in females in any YDQ category. In contrast, services supporting the exchange of information, such as social networking services (SNS), blogs, bulletin boards, and email, were significantly more frequently used by females than by males among the three YDQ groups.

Regarding the types of electronic devices used within the preceding 30 days, personal computers were most often used, followed by smartphones, among all YDQ groups of both genders (Table 4). Again, the percentages of devices endorsed were the highest in students with

Table 2
Distribution of YDQ categories by gender and school year.

School year	Male				Female				Total			
	No use N (%)	AIU N (%)	MIU N (%)	IUD N (%)	No use N (%)	AIU N (%)	MIU N (%)	IUD N (%)	No use N (%)	AIU N (%)	MIU N (%)	IUD N (%)
7th	1189 (17.2)	4983 (72.0)	565 (8.2)	183 (2.6)	733 (11.3)	4668 (72.0)	741 (11.4)	343 (5.3)	1922 (14.3)	9651 (72.0)	1306 (9.7)	526 (3.9)
8th	765 (11.7)	4869 (74.3)	686 (10.5)	236 (3.6)	480 (7.6)	4469 (70.6)	878 (13.9)	501 (7.9)	1245 (9.7)	9338 (72.5)	1564 (12.1)	737 (5.7)
9th	692 (11.2)	4273 (69.1)	817 (13.2)	404 (6.5)	432 (7.2)	3966 (65.9)	1048 (17.4)	573 (9.5)	1124 (9.2)	8239 (67.5)	1865 (15.3)	977 (8.0)
10th	621 (5.5)	7970 (71.0)	1781 (15.9)	861 (7.7)	239 (2.3)	6533 (63.8)	2250 (22.0)	1225 (12.0)	860 (4.0)	14,503 (67.5)	4031 (18.8)	2086 (9.7)
11th	687 (6.6)	7453 (71.1)	1574 (15.0)	763 (7.3)	246 (2.6)	6330 (66.3)	1976 (20.7)	997 (10.4)	933 (4.7)	13,783 (68.8)	3550 (17.7)	1760 (8.8)
12th	841 (8.2)	6955 (68.1)	1656 (16.2)	763 (7.5)	448 (4.6)	6319 (64.3)	1981 (20.1)	1087 (11.1)	1289 (6.4)	13,274 (66.29)	3637 (18.1)	1850 (9.2)
Total	4795 (9.3)	36,503 (70.8)	7079 (13.7)	3210 (6.2)	2578 (5.3)	32,285 (66.6)	8874 (18.3)	4726 (9.8)	7373 (7.4)	68,788 (68.8)	15,953 (15.9)	7936 (7.9)

Note: YDQ: Young's Diagnostic Questionnaire. No use: Did not use the Internet in the 30 days prior to the survey. AIU: Adaptive Internet use. MIU: Maladaptive Internet use.

PIU, followed by those with MIU and AIU for almost all devices. In line with the preference of males for Internet gaming, portable game machines were tended to be used more often by males than by females among all YDQ groups.

3.4. Internet applications and the risk for PIU

Tables 5 and 6 show the results of multiple logistic regression analyses to examine the relationship between Internet applications used and the YDQ categorical groups. The R^2 value for the male model was 0.113 and 0.132 for the female model. The goodness of fit statistics using the chi-square tests was shown under each table. In the male model, all applications were significantly associated with an increased risk for PIU, except for information search services. The results suggested that email use was associated with a reduced risk for PIU. According to the population attributable risk analyses, downloading applications, followed by blog and bulletin board services, contributed most to the increased risk of PIU. Online gaming accounted for 16% of the total attributable risk for males. A similar relationship was observed for females, including a negative association with email use and PIU risk. Unlike males, however, SNS, blogs, and bulletin boards comprised nearly 60% of the population attributable risk, but online gaming accounted for only 5% of the total risk.

4. Discussion

The present study was conducted with >100,000 junior and senior high school students in Japan. To the best of our knowledge, this may be the largest survey ever conducted, in terms of the number of samples of epidemiological research into PIU, among adolescents (Kuss et al., 2014; Moreno et al., 2011). In addition to the sample size, the participating schools were randomly selected from junior and senior high schools nationwide, which supports the assumption that the present sample is a representative of the Japanese adolescent population.

This study revealed that the prevalence of PIU in junior and senior high school students was 6.2% (males), 9.8% (females), and 7.9% (total). When we examined epidemiological studies that used comparable instruments and were conducted on adolescents, we found several studies from Asia and Europe. The prevalence of PIU ranged from 2.0% to 5.9% in studies conducted in Europe (Johansson & Götestam, 2004; Durkee et al., 2012; Siomos, Dafouli, Braimiotis, Mouzas, & Angelopoulos, 2008; Stavropoulos et al., 2013); however, the prevalence was between 2.4% and 21.6% in studies in Asia (Tsai & Lin, 2003;

Table 3
Relationships between daily average hours on the Internet and the YDQ categorical groups by gender.[a]

	Male			Female			Total		
	AIU N = 34,361%	MIU N = 6902%	IUD N = 3127%	AIU N = 30,614%	MIU N = 8702%	IUD N = 4651%	AIU N = 64,975%	MIU N = 15,604%	IUD N = 7778%
Time spent on the Internet on weekdays (hours)[b]									
<1	19.8	7.6	4.6	23.7	8.6	5.3	21.7	8.2	5.0
1 = ≪2	35.4	25.9	20.5	32.5	26.2	19.7	34.0	26.1	20.0
2 = ≪3	16.3	20.5	17.2	16.6	20.6	18.4	16.5	20.6	17.9
3 = ≪5	14.7	21.8	22.7	15.1	23.4	25.4	14.9	22.7	24.3
5 = <	10.6	21.8	33.0	10.2	19.5	30.0	10.4	20.5	31.2
Time not reported[c]	3.2	2.4	2.0	1.7	1.7	1.2	2.5	2.0	1.5
χ^2 Statistics	$\chi^2 = 2879.93$, $df = 10$, $P < 0.001$			$\chi^2 = 3421.35$, $df = 10$, $P < 0.001$			$\chi^2 = 6256.82$, $df = 10$, $P < 0.01$		
Time spent on the Internet on weekends (hours)[b]									
<1	15.0	4.7	2.7	18.3	4.9	2.9	16.6	4.8	2.8
1 = ≪2	30.5	17.6	13.8	28.7	18.4	12.2	29.6	18.0	12.8
2 = ≪3	17.9	18.0	12.7	17.5	18.1	13.5	17.7	18.1	13.2
3 = ≪5	20.1	26.3	23.5	20.4	28.4	27.5	20.2	27.4	25.8
5 = <	15.6	33.2	46.8	14.4	30.1	43.7	15.1	31.4	44.9
Time not reported[c]	1.0	0.2	0.4	0.7	0.1	0.2	0.9	0.2	0.3
χ^2 Statistics	$\chi^2 = 3551.48$, $df = 10$, $P < 0.001$			$\chi^2 = 4492.53$, $df = 10$, $P < 0.001$			$\chi^2 = 7971.83$, $df = 10$, $P < 0.001$		

[a] Those who did not use the Internet in the past 30 days or did not report hours on the Internet were excluded from the table.
[b] Average daily hours spent on the Internet in the past 30 days other than for study purposes.
[c] Time spent on the Internet was not reported.

Table 4
Relationship between types of Internet applications and electronic devices used and the YDQ categorical groups, by gender.[a]

	Male			Female			Total		
	AIU N = 36,503%	MIU N = 7079%	IUD N = 3210%	AIU N = 32,285%	MIU N = 8874%	IUD N = 4726%	AIU N = 68,788%	MIU N = 15,953%	IUD N = 7936%
Type of Internet services used[b,c]									
Information search	70.2	78.2	79.5	68.5	76.9	80.6	69.4	77.5	80.2
E-mail	58.0	65.5	68.0	70.9	76.8	79.0	64.1	71.8	74.6
Chat, Skype, and Messenger	17.8	33.9	44.2	16.3	30.9	41.3	17.1	32.2	42.5
Blog and bulletin board	19.5	39.7	50.7	28.8	48.4	60.6	23.9	44.5	56.6
SNS (Facebook and Twitter)	27.5	44.0	50.7	32.9	54.2	63.4	30.1	49.6	58.2
Online gaming	25.4	43.7	49.5	10.2	18.0	24.4	18.3	29.4	34.6
Downloading programs	65.4	82.5	85.5	62.2	79.7	84.3	63.9	80.9	84.8
Others	11.0	17.6	25.5	9.4	14.8	20.9	10.3	16.1	22.8
Type of electronic devices used[b,c]									
Personal computer (PC)	57.5	65.9	68.9	55.1	59.5	62.5	56.4	62.3	65.1
Portable game machine	17.9	26.2	31.1	7.0	10.9	14.3	12.8	17.7	21.1
Cellphone	26.0	26.8	28.1	35.3	34.1	36.1	30.4	30.8	32.9
Tablet PC	5.1	7.2	9.8	4.1	5.2	6.9	4.7	6.1	8.1
Smartphone	41.6	48.5	49.2	44.1	52.9	53.6	42.8	50.9	51.8
Others	7.0	9.9	11.5	3.5	4.2	5.4	5.4	6.7	7.9

[a] Those who did not use the Internet in the past 30 days were excluded from the table.
[b] Used at least once in the past 30 days.
[c] Percentages did not add up to 100 because of the multiple choice format of the questions.

Cao et al., 2007; Fu et al., 2010; Li et al., 2013). Although methodological differences should be taken into account, the relatively heightened prevalence of PIU in our study may be in line with the existing findings that the prevalence of PIU tends to be higher in Asian countries than in countries from other regions (Kuss et al., 2014; Spada, 2014).

One of the striking findings from our study was that the prevalences of both PIU and MIU were significantly higher in females than in males for all school years and in the total. This differs from previous studies, the majority of which reported a male preponderance (Barke, Nyenhuis, & Kröner-Herwig, 2012; Kuss et al., 2013a, b; Cao, Sun, Wan, Hao, & Tao, 2011). One study, however, did indicate a female preponderance (Liu, Desai, Krishnan-Sarin, Cavallo, & Potenza, 2011). Liu et al. conducted a survey among high school students in Connecticut, USA, and found that the prevalence of problematic Internet use was 3.5% in boys and 4.5% in girls (Liu et al., 2011). In this study, more girls than boys endorsed the subjective measures of PIU, and more girls noted that their families expressed concern about their use and that they tried to cut back, despite the finding that boys spent more hours on the Internet. Based on these observations, the authors suggested that this gender-linked pattern may reflect different rates of development between genders, with high school girls being more mature than boys and thus, having greater insights into their own behaviors and the consequences (Liu et al., 2011). Greater insights could serve to increase the reported prevalence of PIU. This could also be applied to the results of our study.

Alternatively, heightened prevalences of PIU and MIU in females may be related to the Internet applications they used. It has been suggested that females typically prefer to use the Internet for communication, such as SNS, and social reasons, whereas males are more likely to play games (Liu et al., 2011; Ko et al., 2005b). This tendency was confirmed in our study, as will be discussed later. The use of smartphones has dramatically increased among junior and senior high school students in recent years in Japan. A survey conducted by the Cabinet Office of Japan revealed that the use of smartphones for communication purposes also rapidly increased between 2011 and 2013 (Cabinet Office of Japan, 2014). Therefore, the increased prevalence of PIU and MIU in females may be partly explained by the increase in Internet use for communication purposes, which is related to the rapid increase in smartphone use.

Reflecting the high rate of application downloading, the result of logistic regression analyses revealed that these applications contributed the most to the increased prevalence of PIU in both males and females. In contrast, information search services and email did not play a significant role in the occurrence of PIU, although these applications were widely used among the study participants. In the case of email, it was rather negatively associated with a risk of PIU in both males and

Table 5
Multiple logistic regression analyses of types of Internet applications used within the YDQ categorical groups (PIU vs. MIU and AIU) as dependent variables among males[a].

Variables	B	SE	Odds ratio	95% CI		P	PAR[b]
				Lower	Upper		
Intercept	4.07	0.08	0.02			0.00	
School grade	0.13	0.01	1.14	1.11	1.17	0.00	
Information search	0.08	0.05	0.92	0.84	1.01	0.10	−0.06
E-mail	0.28	0.05	0.75	0.69	0.82	0.00	−0.17
Chat, Skype, and Messenger	0.46	0.05	1.59	1.45	1.74	0.00	0.11
Blog and bulletin board	0.70	0.04	2.02	1.85	2.20	0.00	0.20
SNS (Facebook and Twitter)	0.19	0.05	1.21	1.10	1.32	0.00	0.06
Online gaming	0.50	0.04	1.65	1.52	1.79	0.00	0.16
Downloading program	0.53	0.06	1.69	1.52	1.89	0.00	0.32
Others	0.54	0.05	1.71	1.57	1.88	0.00	0.09

[a] Model: $\chi 2 = 2245.86$, $df = 9$, $P < 0.001$. $R^2 = 0.113$.
[b] Population attributable risk.

Table 6
Multiple logistic regression analyses of types of Internet applications used within the YDQ categorical groups (PIU vs. MIU and AIU) as dependent variables among females.[a]

Variables	B	SE	Odds ratio	95% CI		P	PAR[b]
				Lower	Upper		
Intercept	3.68	0.07	0.03			0.00	
School grade	0.06	0.01	1.06	1.04	1.08	0.00	
Information search	0.14	0.04	1.15	1.06	1.24	0.00	0.10
E-mail	0.18	0.04	0.83	0.77	0.90	0.00	−0.14
Chat, Skype, and Messenger	0.48	0.04	1.62	1.51	1.74	0.00	0.12
Blog and bulletin board	0.68	0.03	1.98	1.85	2.12	0.00	0.26
SNS (Facebook, Twitter etc.)	0.56	0.04	1.75	1.63	1.89	0.00	0.23
Online gaming	0.36	0.04	1.44	1.33	1.56	0.00	0.05
Downloading program	0.56	0.04	1.75	1.61	1.91	0.00	0.34
Others	0.65	0.04	1.91	1.76	2.08	0.00	0.10

[a] Model: $\chi 2 = 3123.685$, $df = 9$, $P < 0.001$. $R^2 = 0.132$.
[b] Population attributable risk.

females. The reason for this finding is unclear. Perhaps, email and information search are predominantly used for study purposes among adolescents, a function which acts as a deterrent for addictive Internet use. Previous longitudinal studies have suggested that specific online activities may be more addictive than others (Ko, Yen, Yen, Lin, & Yang, 2007; van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008; Gentile et al., 2011), and the use of information search and email have not been identified as highly addictive in these studies.

In contrast, the addictive nature of online gaming has been shown by both cross-sectional and longitudinal studies. In a cross-sectional study, Durkee et al. (2012) reported that playing online games was the predominant activity for males, with nearly two-fold increases between adaptive and pathological use. The use of online games at baseline has been reported to predict a high incidence of PIU at follow-up in existing cohort studies (Ko, Yen, Yen, Lin, &Yang, 2007; Gentile et al., 2011). In line with these findings, online gaming accounted for 16% of the total population attributable risk of PIU in males in the present study.

In the case of females, applications used for communication with others, such as SNS blogs, bulletin boards, chatting, Skype, and Messenger, greatly contributed to the occurrence of PIU and comprised 60% of the population attributable risk. A recent review has shown that SNS has highly addictive properties and proposed a term and definition for SNS addiction (Andreassen & Pallesen, 2014). A longitudinal study conducted in the Netherlands reported that the use of instant messenger and chatting in chat rooms were risk factors for future PIU (van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008). Another cross-sectional study in the Netherlands reported that in addition to online gaming, social applications, such as online networking sites and Twitter, increased the risk of PIU (Kuss et al., 2013b). These applications, particularly SNS, blogs, and bulletin boards, were female specific and had a significant role in the heightened prevalence of PIU in female students in our study.

Finally, methodological limitations of this study should be mentioned. Firstly, because the data were collected through a self-administered questionnaire and the collected responses were subjective, it is possible that there were differences between prevalence found in this study and the actual prevalence. In addition, surveys were conducted in the classrooms of schools enrolled in the study. Students who were unable to come to schools because of severe PIU were excluded from this study. This may have resulted in an underestimation of the actual prevalence. Secondly, because the questionnaire response rate for junior and senior high schools as a whole was 60.7%, a certain degree of no-response bias may have existed. However, this response rate is considered to be sufficient for this type of epidemiological study. Thirdly, because this study was cross-sectional in design, a causal relationship could not be determined. For example, this study identified a negative association between PIU and the use of email among both males and females. This study was unable to answer the question whether students with PIU tended not to use email or whether the use of email had reduced the risk for PIU. A longitudinal study to elucidate both protective and risk factors and the natural history of PIU needs to be conducted in Japan.

4.1. Conclusion

Internet overuse has been thought to be a serious problem in Japan, but little data has been available on actual conditions. The present study conducted in a large number of students from randomly selected junior and senior high schools in Japan aimed to reveal the magnitude of problems arising from excessive Internet use, particularly PIU. The results showed that 6.2% of male junior and senior high school students and 9.8% of female students were estimated to have PIU. The prevalence of PIU significantly correlated with female gender, school grades, and the number of hours spent on the Internet. Both common and gender-specific application programs that contributed to the occurrence of PIU were identified. Although downloading applications were common for both genders, online gaming was a significant contributor in males, and communication applications, such as SNS, blogs, and bulletin boards, were significant contributors in females. This study revealed that problems associated with Internet overuse have become serious among adolescents, and planning and implementation of prevention and control measures are urgently needed in Japan.

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Contributors

All authors contributed to the design of the study and the writing of the protocol, including the preparation of the questionnaire used in the study. Authors B, E, F, G, H, and I were responsible for conducting the survey, entering the data on a PC, and analyzing the data. Authors C and D conducted literature searches and provided summaries of previous research studies. Authors A and J wrote the first draft of the manuscript, and all authors contributed to and approved the final manuscript.

Conflict of interest

The authors do not have financial relationships with any organizations that might have an interest in the submitted work. They have no other relationships or activities that could influence or appear to have influenced the submitted work.

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